Research Day 2012

Student Presentations

Aldene McClymont M3

Skin Tissue Water via Tissue Dielectric Constant Measurements in Persons with and without Diabetes Mellitus

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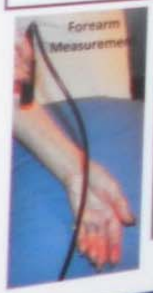
Background

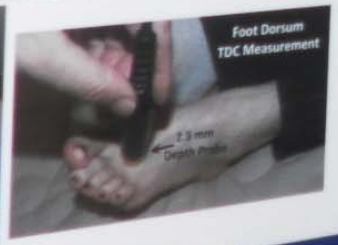
Measurements of local tissue dielectric constant (TDC) via the open-ended coaxial probe method are useful non-invasive measures of local tissue water[1-4]. The method permits assessment and tracking of changes in skin tissue water (STW) in many situations including lymphedema[5] and other conditions[6-10]. The operating principle depends on the direct relationship between TDC values and fluid content within skin that includes epidermal, dermal and vascular tissues. Our specific aim was to determine if STW in persons with diabetes mellitus (DM) is less than in persons without DM (NO-DM). Our motivation stems from the fact that although microvascular and other DM-related skin changes may cause skin dryness and other complications there is no definitive data describing possible DM VS. NO-DM STW differentials.

Methods

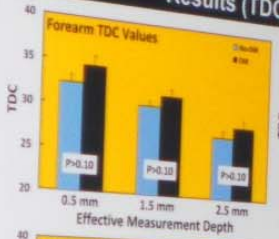
TDC values at depths of 2.5, 1.5 and 0.5 mm were measured bilaterally on anterior forearm and foot dorsum of 36 persons; 18 with DM II and 18 without DM II. Subjects removed shoes and socks/stockings and laid supine with both hands at their sides and their feet uncrossed. Marks were made on the target site of each forearm 8 cm distal to the antecubital fossa. The target site on the foot dorsum was then marked on a flat area between the great and 2nd toe. Girths of forearm and foot at target sites were measured with a calibrated tape measure. TDC measurements were then done in triplicate at each site and each depth. No-DM and DM groups did not differ by age (54.2 ± 18.4 vs. 62.7 ± 12.5 years, p=0.21) or BMI (28.4 ± 4.2 vs. 29.9 ± 5.2kg/m^2; p=0.36). DM duration was 133 ± 132 months and HbA1c was 7.4 ± 1.4.

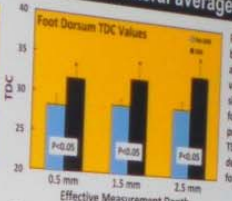
Graphic data are reported as bilateral averages (error bars = 1 sem).



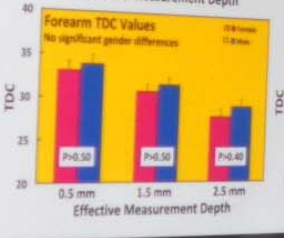


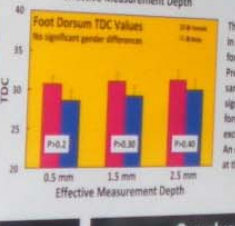
Results (TDC values are bilateral averages)





Forearm TDC values did not differ between NO-DM and DM groups at any depth. In contrast, TDC values of the DM group were significantly greater ($p<0.05$) at the foot at all depths. Interestingly, the previously observed increase in TDC value with decreasing depth[10] was here also observed at forearm but not at foot dorsum.





There was no significant difference in TDC values between genders at forearm or foot at any depth. Previous work[9] based on a larger sample had indicated a slight but significant gender difference at the forearm in which male values exceeded female values by 13%. An opposite tendency is here seen at the foot dorsum.

References

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Conclusions

The greater TDC values found in persons with diabetes was unexpected and contrary to expectations. It is not consistent with the presence of a decreased skin tissue water in DM as was originally hypothesized. It may be that this increased TDC (reflecting an increase in tissue water) may reflect preclinical edema not otherwise visualized. It is also interesting that this NO-DM vs. DM differential was significant only on the feet, an anatomical area that would be especially prone to edema formation. If true- the TDC method may be a useful screening tool for early detection of DM-related edema in certain patients. Further research into this emerging and potentially useful area is clearly indicated.

This research is self-supported;
the authors declare no competing financial interests.

Chris Bell

Vishall Patel

Sequential Variability in Localized Thigh Skin Dermal Tissue Water

Vishall Patel[1] OMS-1, Chris Bell[1] OMS-1, Heng Lee[1] OMS-1, Harvey N. Mayrovitz[2] PhD
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Background

Skin tissue dielectric constant (TDC) measurements have been used as indices of local skin tissue water and its change in a variety of clinically-related applications. Biophysical values have been reported at various anatomical sites, but the temporal variability in lower extremity TDC values in young adults has not been previously reported. Since TDC values vary by anatomical site, such information is valuable directly as a reference and also to help set criteria for sequential studies in which measurements are made in patients over days or weeks. Thus the goal of this research was to use TDC measurements as part of research training program to study variability of these values over time in lower extremities.

TDC Measurement Methods

The device we used to measure TDC was the MoistureMeter-D. It consists of a cylindrical probe connected to a control unit that displays the TDC value when the probe is placed in contact with the skin. A very low intensity 300MHz signal is generated within the control unit and is transmitted to the tissue via the probe that is in contact with the skin.The probe acts as an open-ended coaxial transmission line. The portion of The incident electromagnetic wave that is reflected depends on the tissue dielectric constant, which itself depends on the amount of free and bound water in the tissue volume through which the wave passes. The reflected wave information is processed and the dielectric constant is displayed. For reference, pure water has a value of about 78. The effective measurement depth depends on probe dimensions with longer spacing between inner and outer conductors corresponding to greater penetration depths. In the present study a probe with effective measurement depth of 1.5mm was used.

Figure 1. TDC Measurement device and 1.5 mm depth probe.

Measurement Methods

Self-TDC measurements were performed by six male student research trainees on the proximal one-third of the right anterior thigh while in a seated position at five separate sessions: day 0, day 1, day 7, day 21 and day 28 (Fig. 2). Twenty-four hours prior to each session (except day 1) , the students shaved the region of their anterior thigh to be measured. Self-measurements were taken with the students at rest in a seated position with the legs touching the floor for at least 5 minutes prior to taking any measurements. At each session TDC was measured in triplicate to a skin depth of about 1.5 mm, which is a depth that includes the epidermis and dermis but not the underlying hypodermis or subcutaneous fat. A person not involved with the measurements analyzed the data.

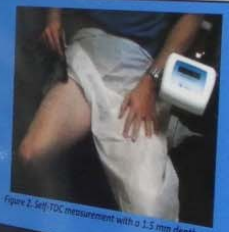

Figure 2. Self-TDC measurement with a 1.5 mm depth probe.

References

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Results

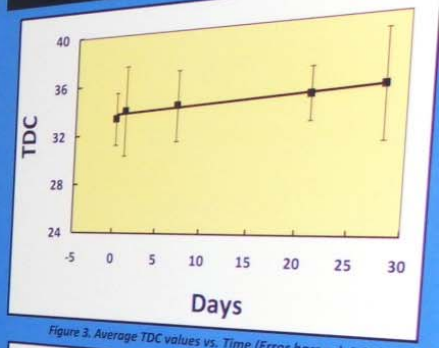

Figure 3. Average TDC values vs. Time (Error bars = ± 1 SD)

TDC values for five sequential measurement sessions (mean ± SD) were respectively 33.3 ± 2.1, 33.9 ± 3.6, 34.1 ± 2.8, 34.5 ± 2.0, and 34.9 ± 4.0. ANOVA analysis for repeated measures showed no overall time effect ($p=0.629$) but an increasing trend appears present for the mean values shown in figure 3. As compared to day 0, subsequent TDC mean values increased sequentially by 1.7%, 2.6%, 3.6% and 4.5%. It is unclear as to the cause of this apparent (but not significant) increasing trend.

Conclusions

The present findings are the first documentation of the magnitude and sequential changes of thigh dermal tissue water determined by local TDC measurements. Since it is known[1-2] that TDC values vary among anatomical sites these results add to the growing reference database of TDC values. Such reference values are needed as first steps in characterizing normal values to pave the way for clinical assessments. Interestingly, the overall average TDC value herein determined, taking into account all measurements (n=30), was 34.2 ± 2.8, which was similar to values previously determined in forearm dermis of 30 male subjects (33.2 ± 4.0[3]) and in cheek dermis (35.9 ± 4.9[4]). The maximum difference in TDC values was less than 5% and occurred between day 0 and day 28 thus indicating good measurement repeatability associated with the TDC measurement method.


Louis
Sharien
Eric
Skin Tissue Water Variations in Different Races Measured via the 300 MHz Tissue Dielectric Constant Method
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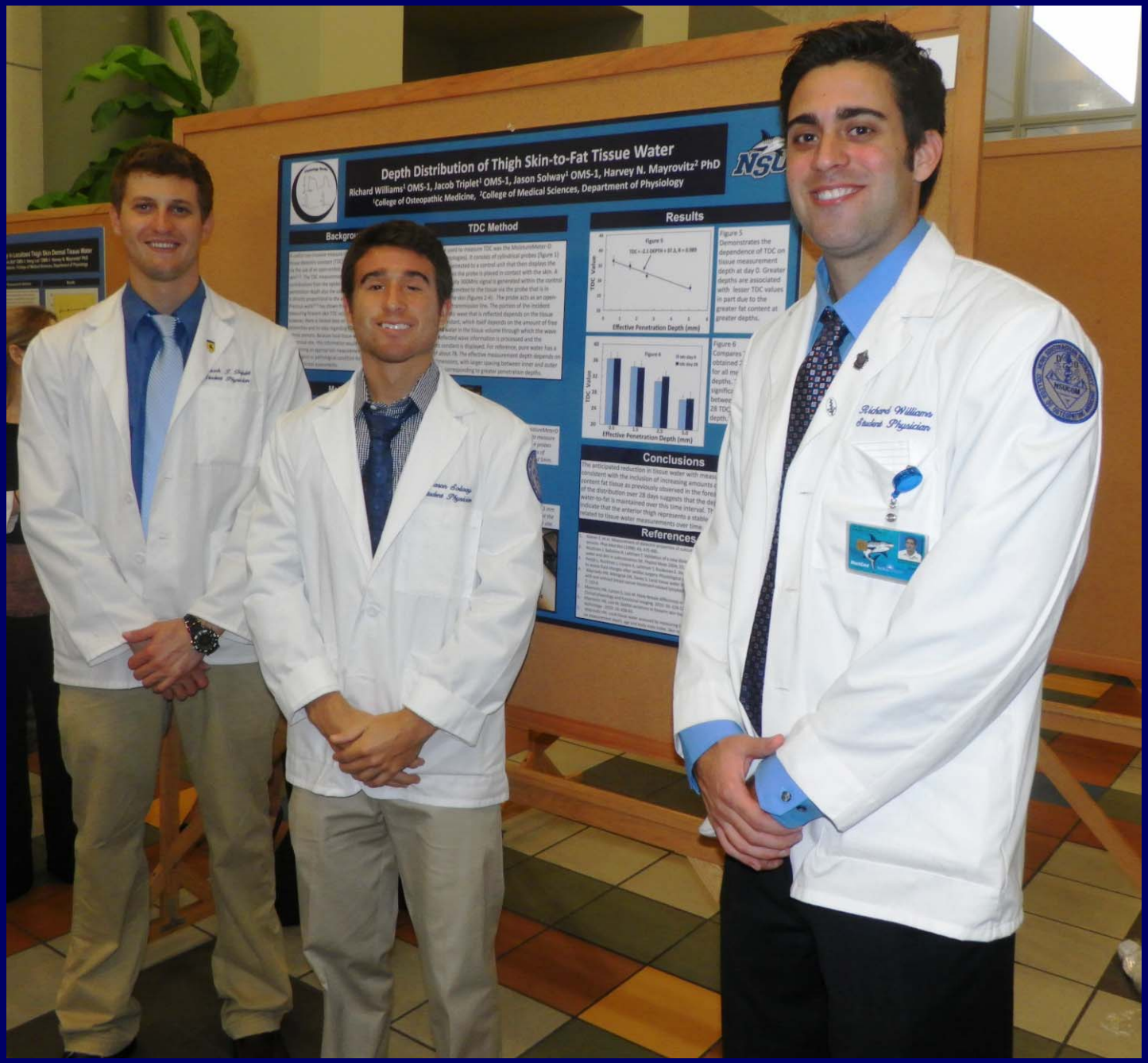
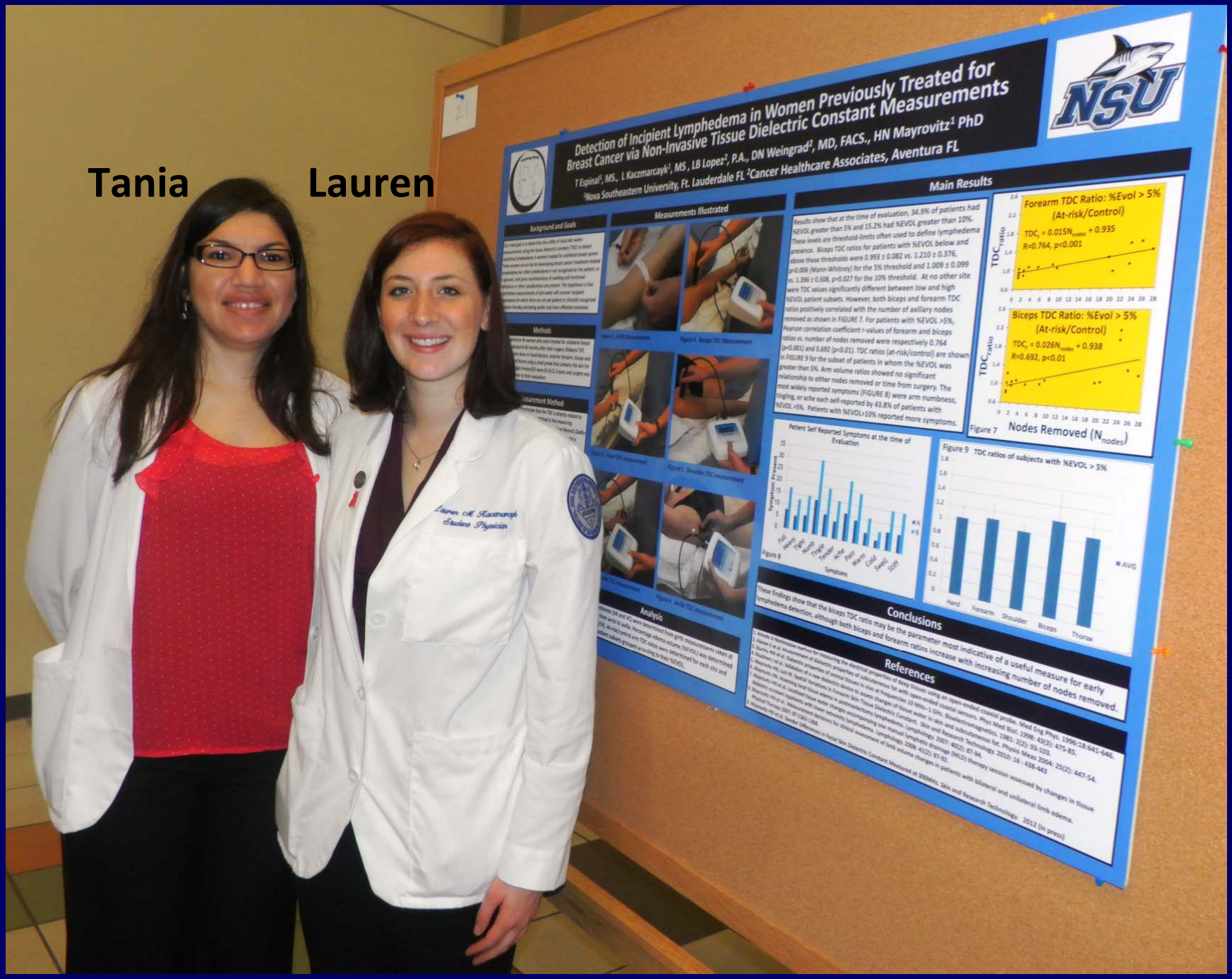
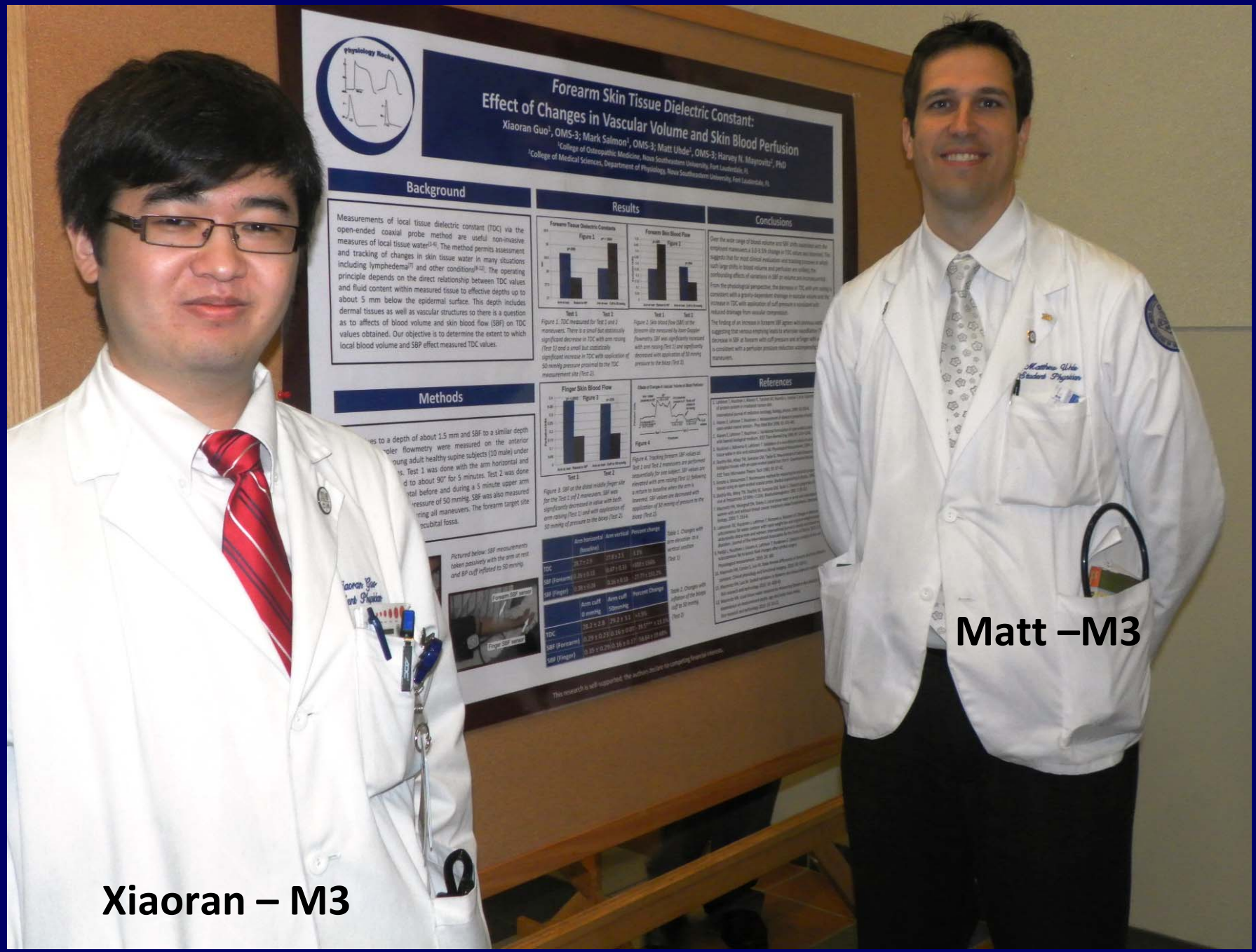
NOVA SOUTHEASTERN UNIVERSITY
Background
Purpose
Methods
Results
Figure 9
TDC Value
chest
arm
ankle
Figure 10
TDC - 5 mm - Forearm
Total Body Water (%)
Conclusions
References



Jacob Jason Ricky


Tania
Lauren
Detection of Incipient Lymphedema in Women Previously Treated for Breast Cancer via Non-Invasive Tissue Dielectric Constant Measurements
T Espinal[1], MS., L Kaczmarcayk[1], MS , LB Lopez[2], P.A., DN Weingrad[2], MD, FACS., HN Mayrovitz[1] PhD
[1]Nova Southeastern University, Ft. Lauderdale FL [2]Cancer Healthcare Associates, Aventura FL
NSU
Background and Goals
Methods
Measurement Method
Measurements Illustrated
Analysis
Main Results
Forearm TDC Ratio: %Evol > 5% (At-risk/Control)
TDC = 0.015N nodes + 0.935
R=0.764, p<0.001
Biceps TDC Ratio: %Evol > 5% (At-risk/Control)
TDC = 0.026N nodes + 0.938
R=0.692, p<0.01
TDC ratio
Nodes Removed (N nodes)
Figure 7
Patient Self Reported Symptoms at the time of Evaluation
Symptom Present
Symptoms
Figure 8
Figure 9 TDC ratios of subjects with %EVOL > 5%
AVG
Hand
Forearm
Shoulder
Biceps
Thorax
Conclusions
References


Forearm Skin Tissue Dielectric Constant:
Effect of Changes in Vascular Volume and Skin Blood Perfusion
Xiaoran Guo[1], OMS-3; Mark Salmon[1], OMS-3; Matt Uhde[1], OMS-3; Harvey N. Mayrovitz[2], PhD
[1]College of Osteopathic Medicine, Nova Southeastern University, Fort Lauderdale, FL
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Background
Methods
Results
Conclusions
References
Xiaoran – M3
Matt –M3

Students and Dr. Mayrovitz


Skin Tissue Water Variations in Different Races Measured
via the 300 MHz Tissue Dielectric Constant Method
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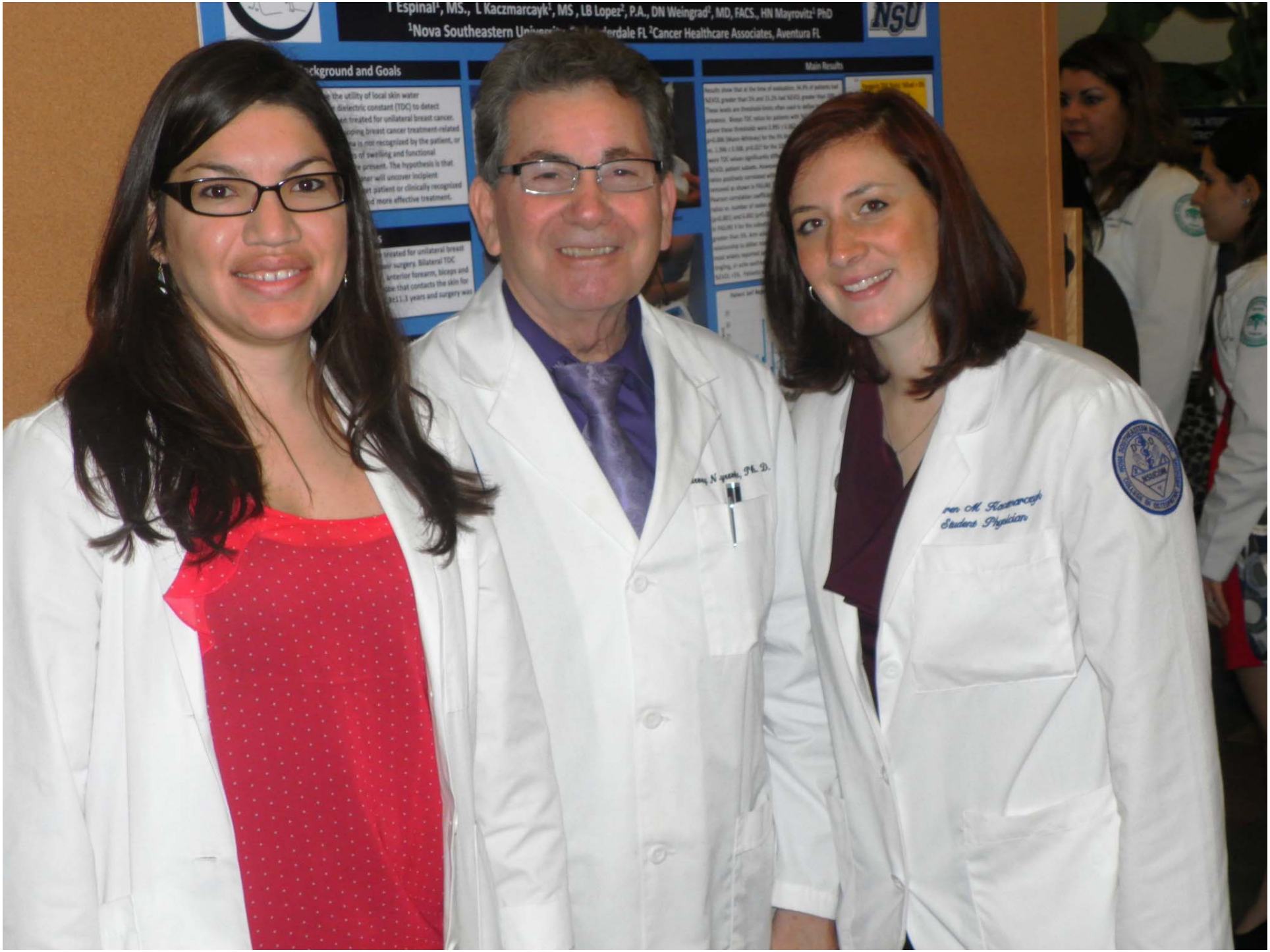
[1]College of Osteopathic Medicine,
Department of Physiology
Background
Results
Louis Michaelos
Student Physician


Main Results
Student Physician


Depth Distribution of Thigh Ski
Background
TDC Method
Results


Sequential Variability in Localized Thigh Skin Dermal Tissue Water
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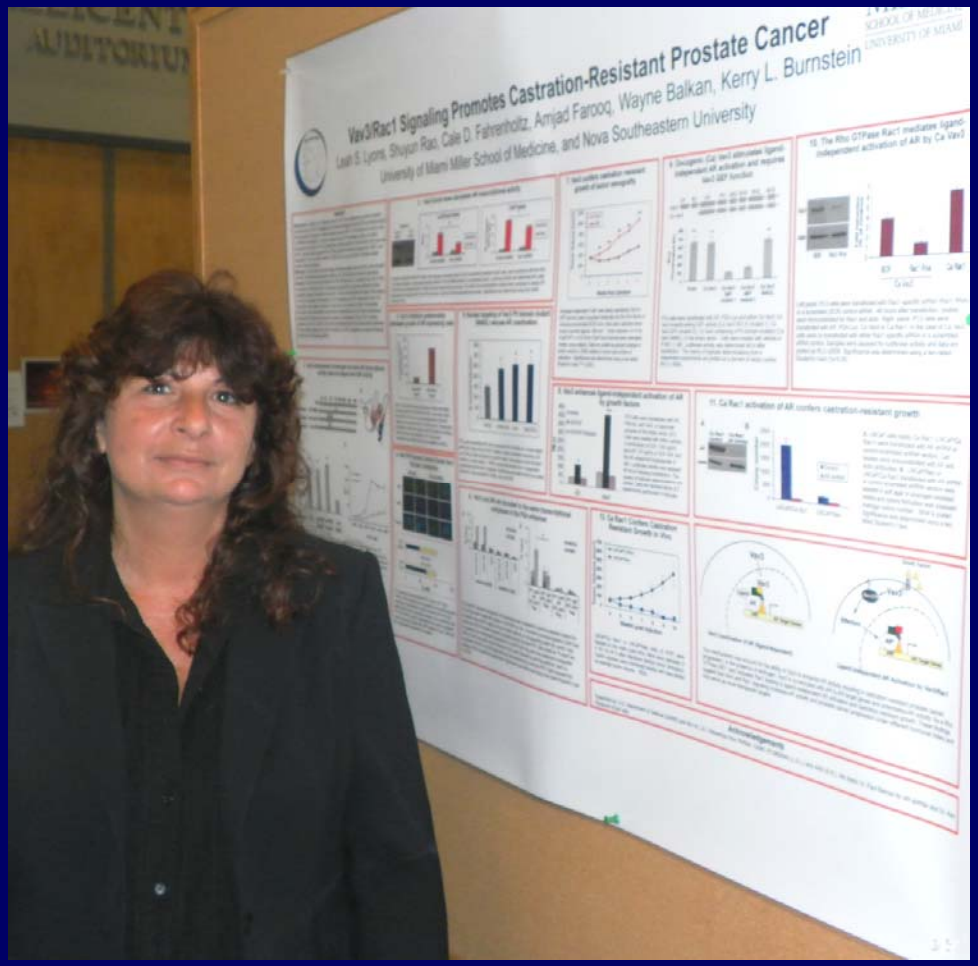
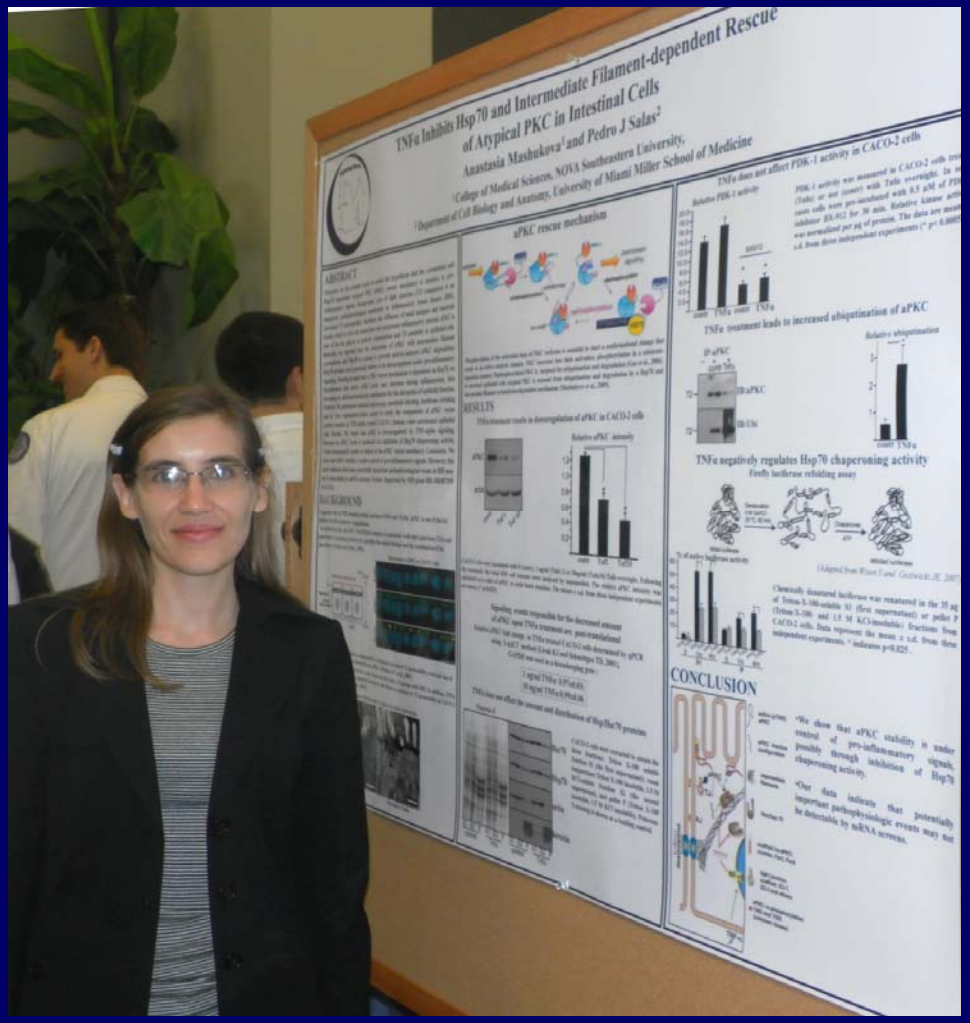
[1]College of Osteopathic Medicine, [2]College of Medical Sciences, Department of Physiology
Background
TDC Measurement Methods
Results
TDC
Days
Figure 3. Average TDC values vs. Time (Error bars = ± 1 SD)
Conclusions

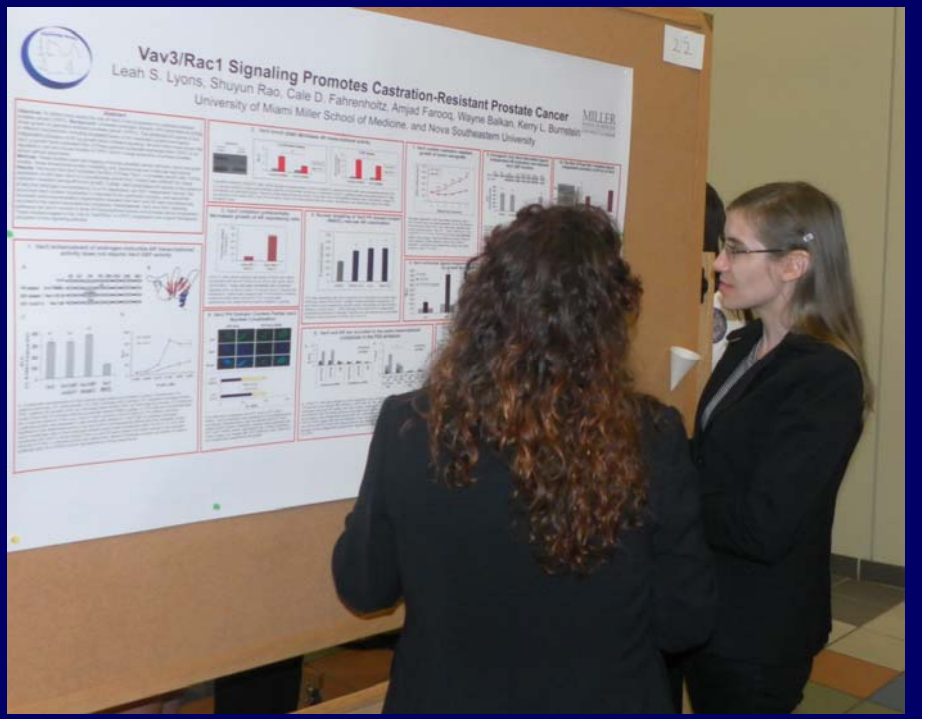
Faculty Presentations
College of Medical Sciences

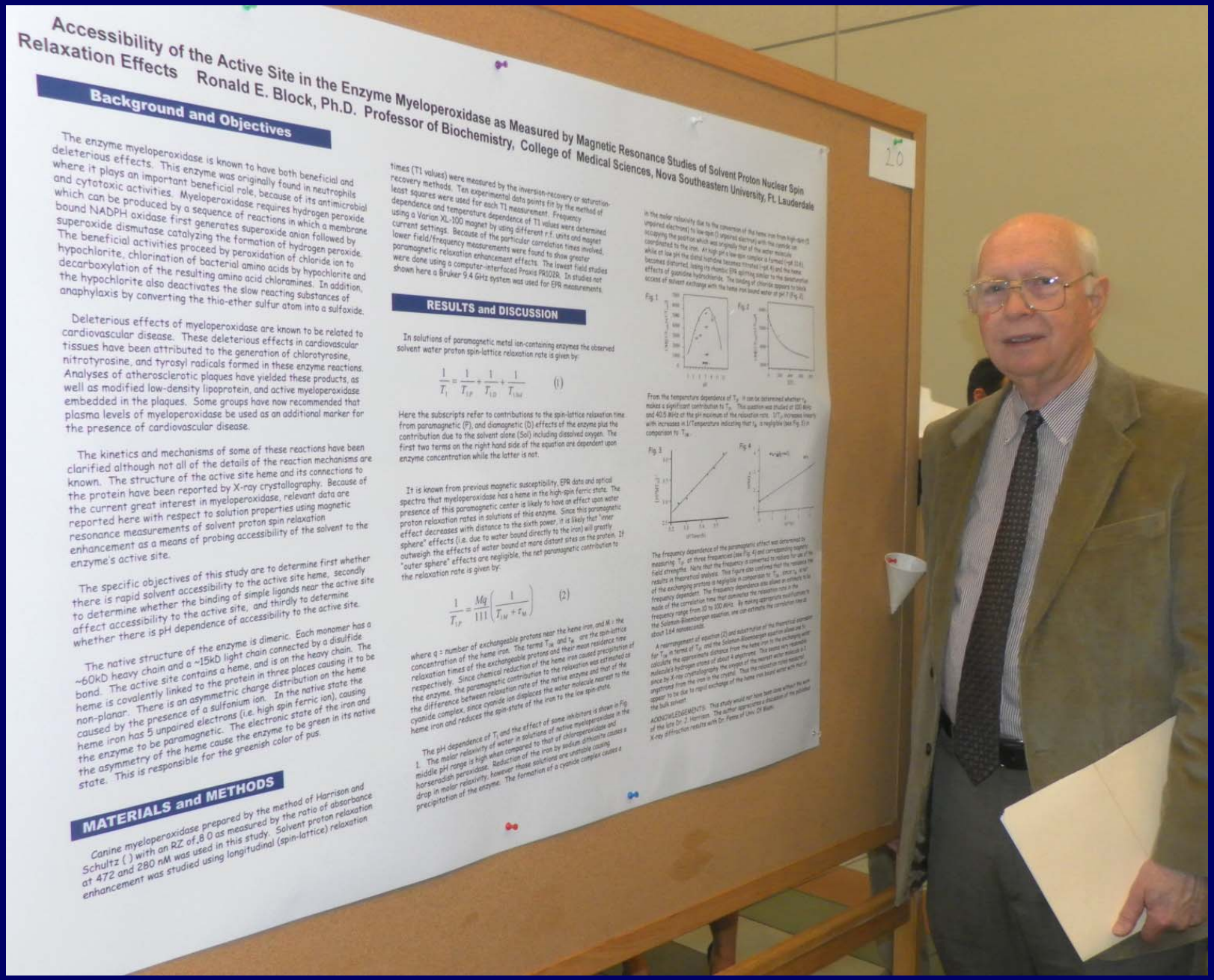


Dr. Leah Lyons
Physiology

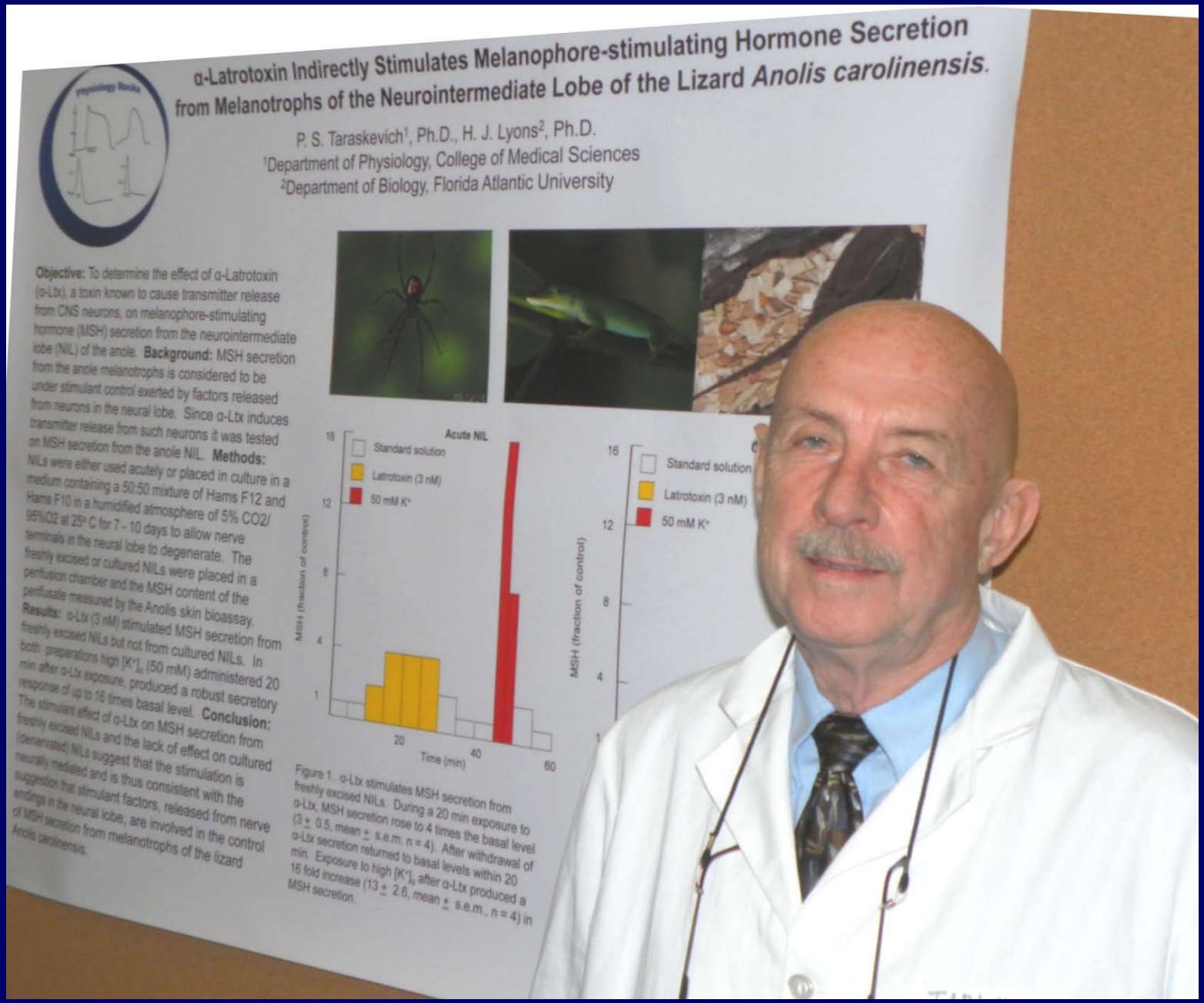


Dr. Anastasia Mashukova
Physiology

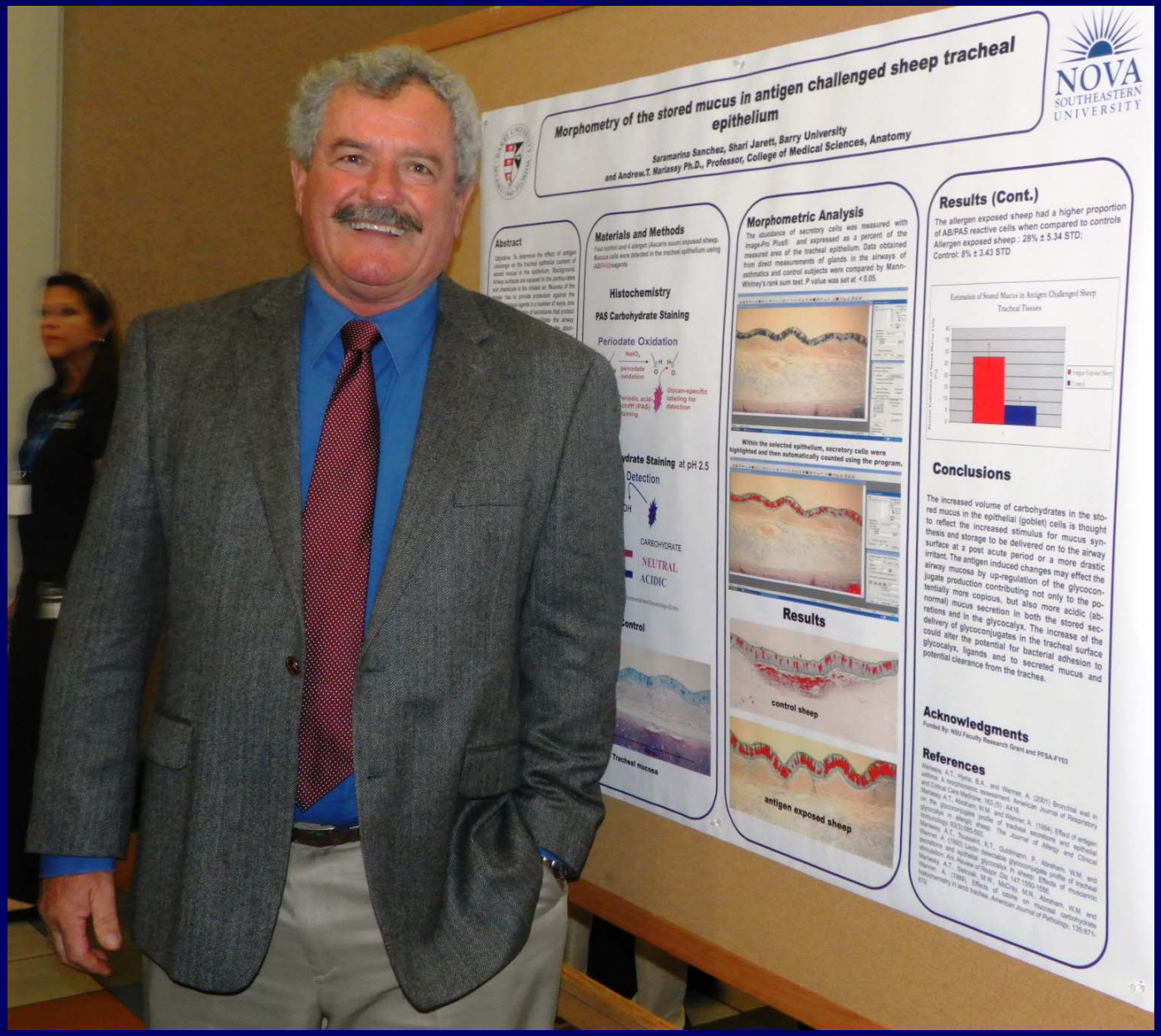




Dr. Ronald Block - Biochemistry



Dr. Stephen Taraskevich - Physiology



Dr. Andrew Mariassy - Anatomy

Dr. HN Mayrovitz
2/11/2012

This was the best Research Day to date
Hope you all enjoyed it and the photos
Lets look forward to Research Day 2014
And always remember that
Physiology Rocks